BELGIAN DAY ON BIOMEDICAL ENGINEERING
ELECTRONIC SPINAL POSTURE DETECTION

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Abstract

A wearable automatic monitoring system for back posture has been developed and tested. Making use of only five accelerometers placed on strategic locations on the back, a stand alone system enables detection, logging and feedback of the patient's posture. The system enables alerting the patient of a bad posture, or long-term data logging to analyze the patient's posture over a prolonged period.

1 Introduction

An increasing number of people have a sitting occupation, with fixed positions for prolonged periods of time, leading to a rising number of back and neck problems [1]. As there is no ideal posture suiting every individual, abstraction is made of what is clinically the ideal posture. The user decides for himself what he feels as a comfortable and correct position. Using this flexibility, a system can be devised suitable for any individual and adjustable over time.

2 System design

The main physiological parameter to monitor the posture is the curvature of the spinal column. By placing accelerometers at known locations on the back, the posture of the person can be extracted. Optionally additional biomedical signals such as activity [2], falling [3] and breathing [4] can be monitored.

For detecting the gravity vector inclination in X,Y and Z direction for every monitoring point, a compact digital output capacitive tri-axial accelerometer was selected, the LIS302DL, with a range of 2g at 8 bit resolution. Three accelerometers are placed at the curve transitions between cervical, thoracic and lumbar region of the spinal column (Fig. 1), being the most sensitive to a change in sitting position. Two additional sensors are mounted on the left and right shoulder, to check for bending. An extra accelerometer at the upper legs detects the angle between the torso and lower limbs.

3 Application design

A Microchip PIC16F690 [4] microcontroller retrieves the accelerometer data sequentially through the SPI protocol from all six accelerometers, and serially sends this to a connected PC. A Matlab application, that receives the serial data through its serial communications port, processes the data, and shows the back posture in real-time on the PC screen. (Fig. 1)

The Matlab user interface asks the user to hold and confirm his correct posture, logging this position by

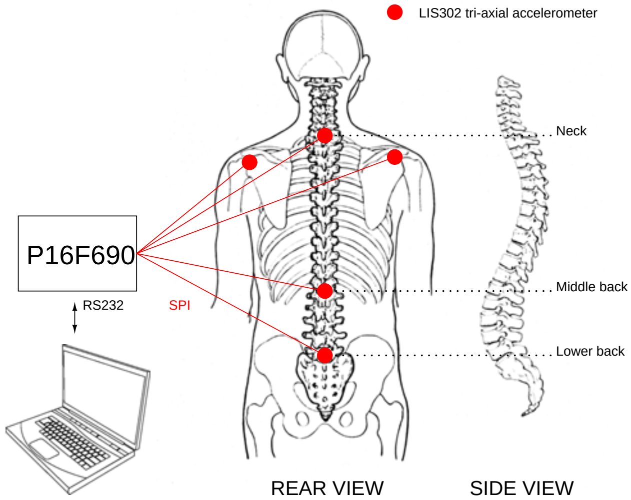

Figure 1 Accelerometer placement and block diagram for posture monitoring system

storing the six accelerometer values and calculating their corresponding vector angles. Next, the posture is continuously monitored, comparing the accelerometer angles to the stored ideal vector angles. When the deviation becomes larger than an arbitrary threshold for a certain amount of time, the user is alerted of his bad posture. When the user adjusts his posture back to within the threshold limits, the user is informed, and the alert timer is reset.

4 Conclusion and future work

A compact wearable solution based on tri-axial accelerometers was developed, to continuously monitor the back posture of the wearer. Visual feedback on the back posture is provided, allowing the user to continuously optimize his back posture. Future improvements will enhance the user comfort: wireless power and data transfer allow for an autonomous hassle-free solution, integrated into the wearer's shirt. A decrease in the number of sensors must be investigated to reduce the cost and increase the wearing comfort even further.

References

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